CAREERS IN PHYSICS

The Invisible Universe

Go outside on a cloudless night and look up. You might see the Moon, a few planets, and many stars. The universe stretches before you, but your eyes are not taking in the full picture. Astronomer Dr. Samar Safi-Harb and her colleagues see a very different universe by using instruments that detect X rays and several other wavelengths of electromagnetic radiation that are invisible to the human eye.

Dr. Samar Safi-Harb

Dr. Safi-Harb is an assistant professor with the Department of Physics and Astronomy at the University of Manitoba. She uses the instruments aboard satellites such as NASA's Chandra X-ray Observatory to research the death throes of super-massive stars. When a super-massive star runs out of nuclear energy, it collapses under its own weight and its outer layers burst into space in a violent explosion called a "supernova." In some cases, the mass left behind compacts into a neutron star. This astounding type of star is so dense that all of its matter fits into a volume no larger than that of a city. A neutron star, along with its strong magnetic field, spins incredibly fast — up to several dozen times per second!

A neutron star is a remarkable source of electromagnetic radiation. As its magnetic field spins through space, it creates an electric field that generates powerful beams of electromagnetic waves, ranging from radio waves to gamma rays. If the beams sweeps past Earth, astronomers detect them as pulses, like a lighthouse beacon flashing past. Such neutron stars are called "pulsars."

The Crab Nebula is one of Dr. Safi-Harb's favourite objects in the sky. It is the remains of a star that went supernova in 1054 A.D. The Crab Nebula is energized by fast-moving particles emitted from its central pulsar. "It looks different at different wavelengths," she explains. "The radio image reveals a nebula a few light-years across that harbours low-energy electrons. The diffuse optical nebula shines by intermediate energy particles, showing a web of filaments that trace the debris of the explosion. The X-ray image reveals a smaller nebula — the central powerhouse — containing very energetic particles. Its jets, rings, and wisp-like structures unveil the way pulsars dump energy into their surroundings."

In part, the ground-breaking work of Jocelyn Bell, the discoverer of pulsars, inspired Dr. Safi-Harb to follow this line of research. Although an astronomer, she has a doctorate in physics from the University of Wisconsin, Madison. Few universities today have astronomy programs that stand alone from physics.

Going Further

1. Earth is orbited by a wide array of satellites that explore the sky at high-energy and low-energy wavelengths. Research two or more of these satellites and describe how images taken by them enhance our understanding of the universe.
2. When two objects in space approach or recede from one another at great speed, light emitted from either object appears altered by the time it reaches the other object. Research and describe what astronomers mean when they talk about a "red shift" or a "blue shift" in light.

WEB LINK

www.mcgrawhill.ca/links/physics12

Radio, infrared, optical, X-ray, and gamma-ray images of our galaxy, the Milky Way, can be found on the Internet. You can also learn more about Dr. Safi-Harb's work and see images of several of her favourite objects in space by going to the above Internet site and clicking on **Web Links**.